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ANNUAL REPORT OF PROGRESS, 1964 - 1965

FEDERAL AID IN FISH RESTORATION PROJECT F-5-R-6

SPORT FISH INVESTIGATIONS OF ALASKA

ALASKA DEPARTMENT OF FISH AND GAME  
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## INTRODUCTION

This report of progress consists of Job Segment Reports from the State of Alaska Federal Aid in Fish Restoration Project F-5-R-6, "Sport Fish Investigations of Alaska."

The project during this report period is composed of 23 separate studies designed to evaluate the various aspects of the State's recreational fishery resources. Of these, eight jobs are designed to pursue the cataloging and inventory of the numerous State waters in an attempt to index the potential recreational fisheries. Four jobs are designed for collection of specific sport fisheries creel census while the remainder of the jobs are more specific in nature. These include independent studies on king salmon, silver salmon, grayling, Dolly Varden, a statewide access evaluation program and an egg take program.

A report concerning the residual effects of toxaphene accumulates the findings of a three-year study. The report presented here terminates this segment and is a final report. The information gathered from the combined studies will provide the necessary background data for a better understanding of local management problems and will assist in the development of future investigational studies.

The subject matter contained within these reports is often fragmentary in nature. The findings may not be conclusive and the interpretations contained therein are subject to re-evaluation as the work progresses.

## JOB COMPLETION REPORT

## RESEARCH PROJECT SEGMENT

STATE: ALASKA Name: Sport Fish Investigations of Alaska.

Project No: F-5-R-6 Title: Investigations of Residual Toxaphene Effects in Six Matanuska Valley Lakes.

Job No: 11-E

Period Covered: January 1, 1962 to December 31, 1964

## ABSTRACT

Six lakes between Palmer and Willow, experimentally rehabilitated in 1961 with a concentration of 10 parts per billion toxaphene, were followed by a three-year study to attempt to determine the effects of the toxicant.

Two series of live car tests were run in 1962 and two series were run in 1963. The last few surviving fish from tests at each lake were sent to a professional laboratory for analysis. Highest mortality occurred during the first test series each year. All samples were taken by gill net in 1964, which were captured fish planted in 1963.

Finger and Willow Lakes were considered detoxified in late 1962. Willow Lake was not stocked due to reinfestation, but Finger Lake received a plant of hatchery-reared rainbow trout. The four barren study waters were considered detoxified in 1963, and were planted with rainbow trout. Test net studies in 1964 showed survival of planted game fish in all test lakes. The deepest water, Florence Lake, contained the highest toxin residue at the close of study. Willow Lake was reinfested with stickleback in 1962, and Crystal and Finger Lakes were reinfested in 1963. Mud and water samples taken in 1962 and 1963 contained no significant amounts of residual toxin.

Road and weather conditions severely restricted invertebrate succession studies, although it was noted that all waters exhibited low basic productivity. The best invertebrate populations were present in Finger and Willow Lakes.

Relative toxicity among the test waters appeared to be contingent on maximum depth and percentage of water volume below the plant production level.

#### RECOMMENDATIONS

1. It is recommended that this study be terminated, since all test waters are now sustaining fishable populations of game fishes.
2. It is recommended that toxaphene be considered as a useful, economical management tool for lake rehabilitation in this area of Alaska. Limitation should be made to eutrophic lakes containing a high percentage of shoal area and vegetation. Lakes with deep areas where the chemical would not oxidize except when brought to the surface during overturn periods should be avoided. Acceptable waters will detoxify in one year if the chemical concentration used does not exceed 10 parts per billion. A small lake not included in this program was treated earlier than the others with 25 parts per billion. Planted fish did not survive there until three years after treatment.
3. It is recommended that Finger Lake be stocked and evaluated by test net and creel census studies each year, and that the remaining test waters be placed on a like basis. Willow Lake should be omitted from the stocking schedule due to the fair native silver salmon population present there.

#### OBJECTIVES

1. To determine the existence and distribution of residual toxaphene in six of the Matanuska Valley Lakes rehabilitated in 1961.
2. To determine the toxicity of these lakes in relation to game fishes.
3. To determine the time these lakes become suitable habitat for game fishes.
4. To provide recommendations for future studies and management of these and similar lakes.

5. To determine invertebrate species succession.

## TECHNIQUES

Six lakes between Palmer and Willow were experimentally rehabilitated in 1961 with a concentration of 10 parts per billion toxaphene. Location of these waters is shown in Figure 1. A three-year study followed in an effort to determine the effects of the toxicant.

In 1962 and 1963 screened live boxes, each containing 15 to 20 wild rainbow trout and silver salmon fingerlings three to five inches long, were introduced to the study lakes. During the second series of tests in 1963, hatchery-reared silver salmon averaging 2 inches long were utilized. Each box consisted of wood frame covered with screen measuring 5 mesh to the inch with a hinged door at one end. Dimensions of the box were 18 x 18 x 30 inches. Before boxes were placed, dissolved oxygen and temperature measurements were made to assure that a suitable natural environment existed at the depths for which the units were destined. Two series of live box tests were run at each lake both years, except at Willow and Finger Lakes. In 1963 sample fish were taken by gill net in these two waters. Willow Lake received a natural plant via its outlet, and rainbow trout had been planted successfully in Finger Lake in 1962. Two control waters, Nancy and Wasilla Lakes, were utilized in conjunction with the live box study. Due to wet road conditions in 1963, which hampered periodic observation of series one test units, all fish expired in Crystal Lake and beavers severed the buoy lines in Bumblebee Lake before surviving fish could be extracted for analysis.

Pilot plants were attempted at the lakes as early as sample results indicated a possibility of survival. The first introduction was made to Finger Lake in 1962. All waters except Willow Lake (restocked naturally) were planted experimentally with rainbow trout in 1963 and 1964. The 1964 plantings to the test waters were made in event of failure of survival of the 1963 introductions in any or all waters.

In July of 1964 fish sample collections were made entirely by gill net from successful 1963 plants in all study waters except Willow Lake. Late returns of 1963 sample results showed that toxicity levels at Willow Lake were low enough to make further sampling costs unnecessary. Experimental gill nets, 125 feet long with 25 foot panels in 1/2, 3/4, 1, 1-1/4 and 1-1/2 inch bar measure increments were utilized. Finger Lake was netted a second time in September in an attempt to determine rate of detoxification, by further

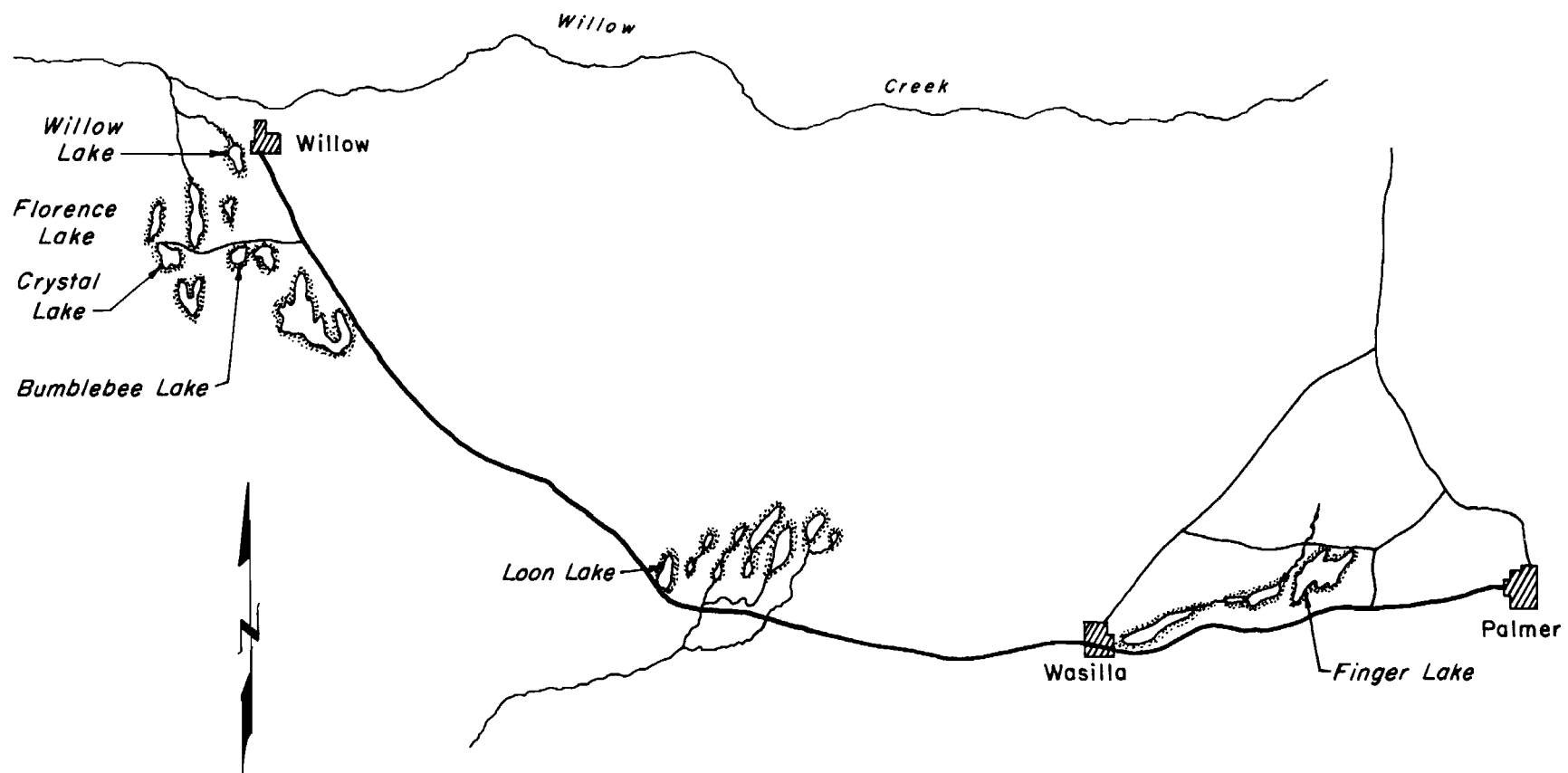


Figure 1. Location of Matanuska Valley Toxaphene-Treated Lakes

analysis of fish flesh.

Water and mud samples were collected from all study lakes and sent for analysis in 1962. Water samples were collected again at Finger Lake in 1963, at the 5-, 20-, and 35-foot levels during the overturn period in May. In October of 1963 a water sample was taken from the 5-foot level of each test lake during the fall overturn period. The 1963 collections were attempts to measure possible upwelling of residual toxin from the lake depths.

Residual toxaphene analyses were made from the last few survivors from each of the live boxes, from netted fish, and from mud, water and invertebrate insect samples. The Food, Chemical and Research Laboratory employed in 1962 and 1963 ceased operations in 1964. The Department of Agricultural Chemistry at Oregon State University was employed for the final series of tests. All sample fish were quick-frozen and airmailed to the testing laboratories.

Attempts to measure invertebrate species succession met with limited success. Eckman dredge techniques failed completely due to the scarcity of organisms. In 1962 a 70- to 100-foot section of shoreline area of each lake was marked off and a dip net was passed through a series of arcs each 6 feet long along the bottom in the test areas at random intervals. Enough passes were taken to obtain a sample adequate for future comparisons. Plankton measurements were made using a standard plankton net. Contents of a 20-foot tow were emptied into a pint container. Three equal samples from each container were observed under a stereomicroscope and the quantitative counts were averaged. In 1963 invertebrate collections were suspended because difficult road conditions prevented collections at the proper time for comparison with 1962 data. In 1964 road conditions again delayed access to test waters until mid-August when collections were attempted. Although the techniques previously used successfully were attempted, the effect of the unusually cool summer restricted adequate collection in Florence Lake where fair numbers of dragonfly larvae were present.

## FINDINGS

Live-car test fish mortality proceeded more rapidly during series one than during series two tests, both in 1962 and 1963, likely due to the possible lower vitality of the test fish at the earlier introduction date. During 1962 test fish in the Finger Lake deep set succumbed from oxygen deficiency

soon after introduction. Tables 1 and 2 contain the 1962 mortality percentages of test fish for both series.

In 1963 all test fish in the Florence Lake deep set died within 11 days after introduction. Numerous stickleback were found in the Crystal Lake live cars, showing that reinfestation had occurred via the intermittent outlet to Long Lake. Table 3 contains the 1963 test fish mortality percentages for series one. Series two fish were removed October 18 when ice formation began. The sole mortalities occurred at Florence Lake, where all fish died in the deep live car after 23 days. Three fish had died in the 5-foot unit at the time of test termination.

All sample fish were collected by gill net in 1964, as 1963 fish overwintered in apparently healthy condition in all stocked test waters. No significant survival comparison among the stocked waters could be made from the samples taken.

Results of the residual toxin analyses of fish flesh for the 3-year study are presented as Table 4, and results of the mud and water tests are summarized in Table 5. The 1962 results indicated that Willow Lake was lowest in toxicity, likely due to its shallow nature and water exchange via inlet springs and the outlet drainage. By late summer wild stickleback and fingerling salmon were observed in the lake. Next lowest in toxicity was Finger Lake, from which test fish mortality showed a 5-percent increase over that of Willow Lake, and 7.5 percent over that of the control, Wasilla Lake. As a result, it was decided to introduce 50,000 rainbow trout to Finger Lake. Willow Lake was omitted from the planting program because stocked fish could leave via the outlet at will, and competing wild salmon and stickleback were present. The remaining four waters appeared too toxic for survival of game fish in 1962.

Results of the 1963 sample analyses showed progressive detoxification of Bumblebee, Crystal, and Florence Lakes, although Florence Lake remained the most toxic water. No significant change was apparent at Finger and Willow Lakes, the two waters considered clear in 1962. Fish resident in the latter two waters had been subject to the residual toxin effects in excess of a year, and were sampled by gill net. A buildup of toxin in the flesh until the end of the spring overturn period was followed by a reduction during the summer season. Between June 18 and September 12 the mass of the fish



TABLE 1. - Mortality Percentages of Live-box Test Fish in Six Matanuska Valley Lakes, from June 22 to August 6, 1962.

Days Tested	LAKES												
	Bumblebee		Crystal		Finger				Florence		Loon		Willow
	5ft. %	15ft. %	5ft. %	15ft. %	16ft. %	*30ft. %	5ft. %	*30ft. %	5ft. %	35ft. %	5ft. %	15ft. %	5ft. %
1											12	18.1	
4			22.2	36.3	26.3	0	20	100	0	0			
6					52.6	0	33.3						
7	65	55.5											0
8											44	72.7	
11			61.1	72.7	57.8	100	33.3		62.5	80			
13	**85	88.8	66.6	72.7					**87.5	86.6			
15			72.2	86.3									
17					63.1		33.3						
18			**88.8	90.9									
20					78.9		46.6						11.7
21											**96	95.4	
23													35.2
27													35.2
28							60						
31													52.9
35						**60							
36													58.8
40													**76.4

\* Dissolved oxygen levels became submarginal.

\*\* Survivors were sent for laboratory toxicity analysis.

TABLE 2. - Mortality Percentages of Live-box Test Fish in Six Matanuska Valley Lakes from August 22 to October 12, 1962.

Days Tested	TEST LAKES											CONTROL LAKES			
	Bumblebee		Crystal		Finger		Florence		Loon		Willow	Nancy		Wasilla	
	5ft. %	15ft. %	5ft. %	15ft. %	5ft. %	16ft. %	5ft. %	35ft. %	5ft. %	15ft. %	5ft. %	5ft. %	15ft. %	5ft. %	15ft. %
5-6			10	10			0	15	0	0				10	0
7-8	5	10			15	5					5	0	0		
12-13					15	5			0	0					
15-16	80	45	25	50			55	70			5	5	0	10	0
19-20			50	75					0	35					
21-22	95	80			15	5	75	90			5	10	0	10	0
25-26			75	85					15	60				10	0
27-28	100	90			15	5	100	100			5	20	0		
31-32									30	80				10	0
33-34					15	5									
35-36		100	85	100							5	35	20		
39-40			100						50	85					
41-42					15	10					5	40	30	20	0
45-46									65	100					
47-48					15	15								45	0
49-50											10	50	45		
53-54									80		10			45	5
55-56					15	35			100						
57-58					15	45									

TABLE 3. - Mortality Percentages of Live-car Test Fish in Five Matanuska Valley Lakes from July 10 to September 14, 1963.

Days Tested	TEST LAKES								CONTROL LAKE	
	Bumblebee		Crystal		Florence		Loon		Nancy	
	5ft. %	15ft. %	5ft. %	15ft. %	5ft. %	15ft. %	5ft. %	15ft. %	5ft. %	15ft. %
7	19	31							25	25
11					31	100	6	31		
12			50	50					50	50
16	31	50								
20							13	63		
21			50	75						
29	38	63			44				63	56
33							13	75		
34			100	75						
39									100	69
40	38	100								
42					63*					
48										75
52	car missing			100						
60										100
64							19*	75		

\* Survivors removed for residual toxaphene analysis.

TABLE 4. - Results of Analysis of Residual Toxaphene Content of Fish and Insect Flesh, in Parts Per Billion, 1962-1964.

<u>Lake</u>	<u>*Species</u>	<u>Year</u>		
		<u>1962</u>	<u>1963</u>	<u>1964</u>
Bumblebee	Rt	1400	100	**none detected
Crystal	Rt	500	100	144***
Finger	Rt	**none detected	100	July - **none detected September - 150
Florence	SS	--	--	**none detected
	Rt	1000	600	299
	Insects	--	--	**none detected
Loon	Rt	400	500	**none detected
Willow	SS	100	June - 200 September - 100	-- --

\*Rt - rainbow trout

SS - silver salmon

\*\* less than 100ppb.

\*\*\* Analysis conducted by different laboratory.

TABLE 5. - Results of Analysis of Residual Toxaphene Content of Mud Water Samples, in Parts per Billion, 1962-63.

<u>Lake</u>	<u>Year</u>	<u>Sample</u>			<u>** Toxaphene Concentration</u>
		<u>Type</u>	<u>Size</u>	<u>Depth</u>	
Bumblebee	1962	water	1 gal.	10'	0.75
		water	2 qts.	25'	*none detected
		mud	2 qts.	10'	150
		mud	1 qt.	30'	less than 50
	1963	water	1 gal.	5'	*none detected
Crystal	1962	water	1 gal.	10'	0.5
		water	2 qts.	16'	*none detected
		mud	2 qts.	9'	50
		mud	1 qt.	19'	less than 50
	1963	water	1 gal.	5'	*none detected
Finger	1962	water	1 gal.	10'	*none detected
		water	2 qts.	32'	*none detected
		mud	2 qts.	10'	less than 250
		mud	1 qt.	35'	less than 150
	1963	water	1 gal.	5' spring test	*none detected
		water	1 gal.	20' "	*none detected
		water	1 gal.	35' "	*none detected
		water	1 gal.	5' fall test	*none detected
Florence	1962	water	1 gal.	10'	less than 1.0
		water	2 qts.	32'	0.5
		mud	2 qts.	10'	less than 250
		mud	1 qt.	37'	less than 350
	1963	water	1 gal.	5'	*none detected
Loon	1962	water	1 gal.	6'	0.5
		water	2 qts.	18'	*none detected
		mud	2 qts.	6'	50
		mud	1 qt.	20'	less than 50
	1963	water	1 gal.	5'	*none detected
Willow	1962	water	1 gal.	5'	*none detected
		water	2 qts.	8'	*none detected
		mud	2 qts.	6'	less than 50
		mud	1 qt.	12'	less than 50
	1963	water	1 gal.	5'	*none detected

\* less than 0.5

\*\* Extent of determination was dependent upon condition of sample received.

samples at Willow Lake increased about 4.4 times, while the flesh content toxicity decreased by 50 percent. Fish mass increased about 6.8 times at Finger Lake while flesh content toxicity decreased by 93.7 percent, between May 17 and September 12. Following a study of live-car mortality patterns and analysis results, a decision was made to introduce rainbow trout experimentally to the four barren test waters. Finger Lake received a second plant of 87,000 fingerling silver salmon. At that time it was noted that a small population of stickleback was present. Willow Lake was again omitted from the planting program due to natural reinfestation.

A list of experimental plantings to the test lakes during the study period is included as Table 6, below.

TABLE 6. - Experimental Planting Densities for Six Toxaphene-Treated Study Lakes, 1962-64.

Lake	Year	*Species	Total Fish
Bumblebee	1963	Rt	5,000
	1964	Rt	2,500
Crystal	1963	Rt	10,000
	1964	Rt	5,000
Finger	1962	Rt	50,000
	1963	SS	87,000
	1964	Rt	18,000
Florence	1963	Rt	8,000
	1964	Rt	4,000
Loon	1963	Rt	10,160
	1964	Rt	2,500

\*Rt - rainbow trout

SS - silver salmon

July and September test net studies in 1964 disclosed that numbers of fish in healthy condition had overwintered successfully in all study lakes. Comparison of July and September test results at Finger Lake showed no significant change in the toxicity level. Mud and water tests were suspended due to the insignificant amounts of toxin found in

TABLE 7. - A Comparison of Physical Characteristics, plus Residual Toxaphene Content and Mortality of Test Fish in Six Treated Lakes, 1962-1964.

<u>Lake</u>	<u>Max. Depth in Feet</u>	<u>Thermo- cline</u>	<u>Toxaphene in Fish Flesh</u>		<u>Test Fish Mortality</u>	
			<u>Year</u>	<u>*Content, p.p.b.</u>	<u>No. Days</u>	<u>Percentage</u>
Willow	11	no	1962	100	54	10
			1963	June - 200		
				September - 100		
Finger	44	yes	1962	**none detected	58	30
			1963	100		
			1964	July - **none detected September - 150		
Loon	20	no	1962	400	56	100
			1963	500	64	47
			1964	**none detected		
Crystal	25	no	1962	500	40	100
			1963	100	52	100
			1964	144		
Bumblebee	37	yes	1962	1400	36	100
			1963	100	40	69
			1964	**none detected		
Florence	40	yes	1962	1000	28	100
			1963	600	42	81.5
			1964	299		

\* Parts per billion

\*\* less than 100

previous samples. Results of laboratory analysis of fish flesh showed that Florence Lake maintained the highest level of toxicity. The apparent slight rise in toxicity of Crystal Lake, although insignificant, may be the result of technique deviations between the two laboratories utilized in 1963 and 1964.

Results of plankton and invertebrate species sampling in 1962 showed that low populations were present in all waters, which is considered partly due to the low basic productivity of these lakes. Willow and Finger Lakes contained the best populations which included fair numbers of Sigara and low numbers of Gammarus.

Relative toxicity of fish flesh appears to be a function of maximum depth and percentage of water volume below plant production levels. Table 7 compares physical characteristics, residual toxin contents, and test fish mortalities at the six lakes. Finger Lake is not the exception it would seem. The two deep areas of small size and the extensive, undulating shoreline result in a small percentage of water volume below the plant production level. The other lakes involved fall into the characteristic bowl shape category.

Factors working against detoxification in the six study lakes are the short cool summers, long periods of winter ice cover, acid water conditions, and general deficiency of micro-organisms. The breakdown of toxaphene depends upon sunlight, high temperature, oxygen produced from plants and wind agitation, alkaline conditions, and micro-organisms. The more rapid clearing of Willow and Finger Lakes is considered to be the result of higher aquatic plant and algae production and larger percentage of shoal area exposed to sunlight and wind agitation than the other treated lakes involved. In addition, Finger and Willow Lakes are the sole waters in the test group which have small but permanent outlets for water exchange.

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